(12) UK Patent Application (19) GB (11) 2 261 127 (13) A

(43) Date of A publication 05.05.1993

(21) Application No 9222122.5

(22) Date of filing 21.10.1992

(30) Priority data
(31) 03097174 (32) 31.10.1991 (33) JP

(71) Applicant
Hakuju Institute for Health Science Co Ltd

(Incorporated in Japan)

11-2, Toranomon, 1 Chome, Minato-Ku, Tokyo, Japan, Japan

(72) Inventors
Yukio Ogawa
Akikuni Hara

(74) Agent and/or Address for Service
F J Cleveland & Co
40-43 Chancery Lane, London, WC2A 1JQ, United Kingdom

(51) INT CL[5]
H02H 3/08, A61N 1/40

(52) UK CL (Edition L)
H2K KHB KSX K252 K360 K452 K598 K76Y K768
A5R RHFE
U1S S1030

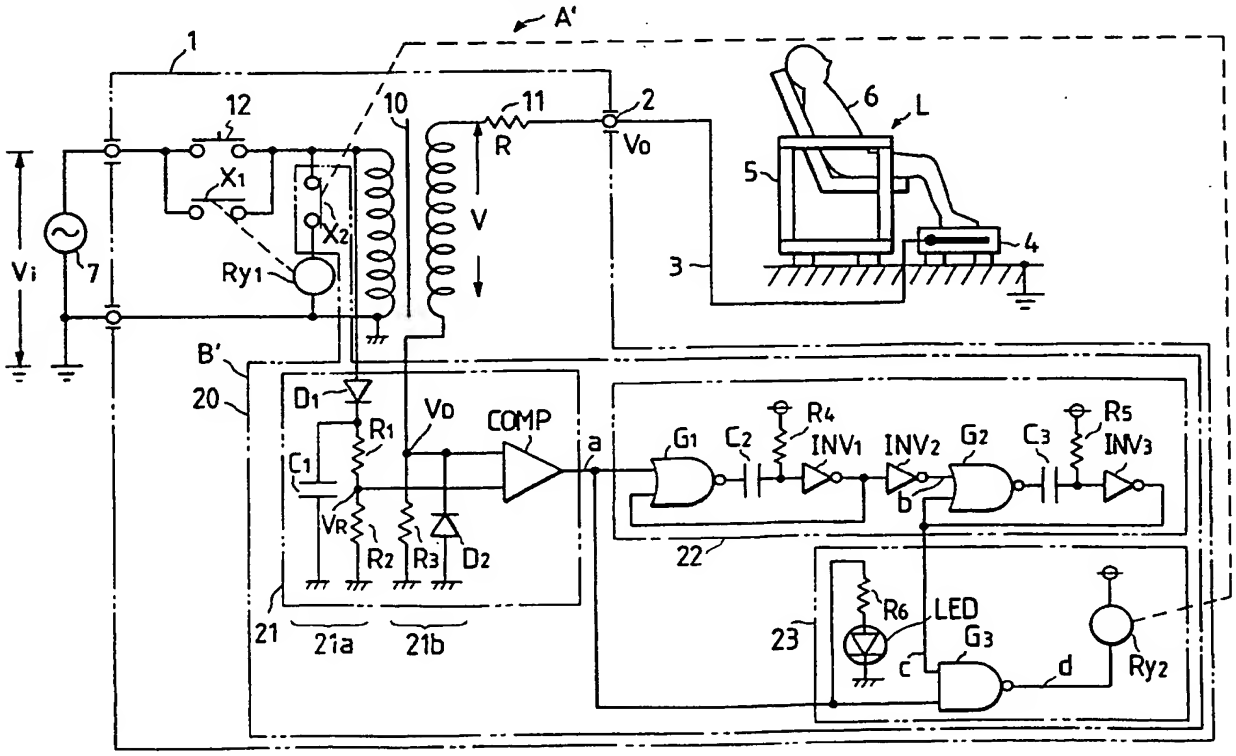
(56) Documents cited
GB 1594021 A GB 0693838 A EP 0269846 A1

(58) Field of search
UK CL (Edition L) A5R RHFE, H2K KHB KSX
INT CL[5] A61N 1/08 1/40, H02H 1/04 3/08 3/093 3/40 7/00
Online databases: WPI

(54) Electric field therapy apparatus

(57) An electric field therapy apparatus comprises an overload detecting circuit 21 which compares (COMP) a voltage V_D dependent on the output current with a reference V_R dependent on the supply voltage. The result drives an indicator (LED) and/or a relay Ry2, possibly via a time delay 22.

FIG. 4



GB 2 261 127 A

FIG. 1

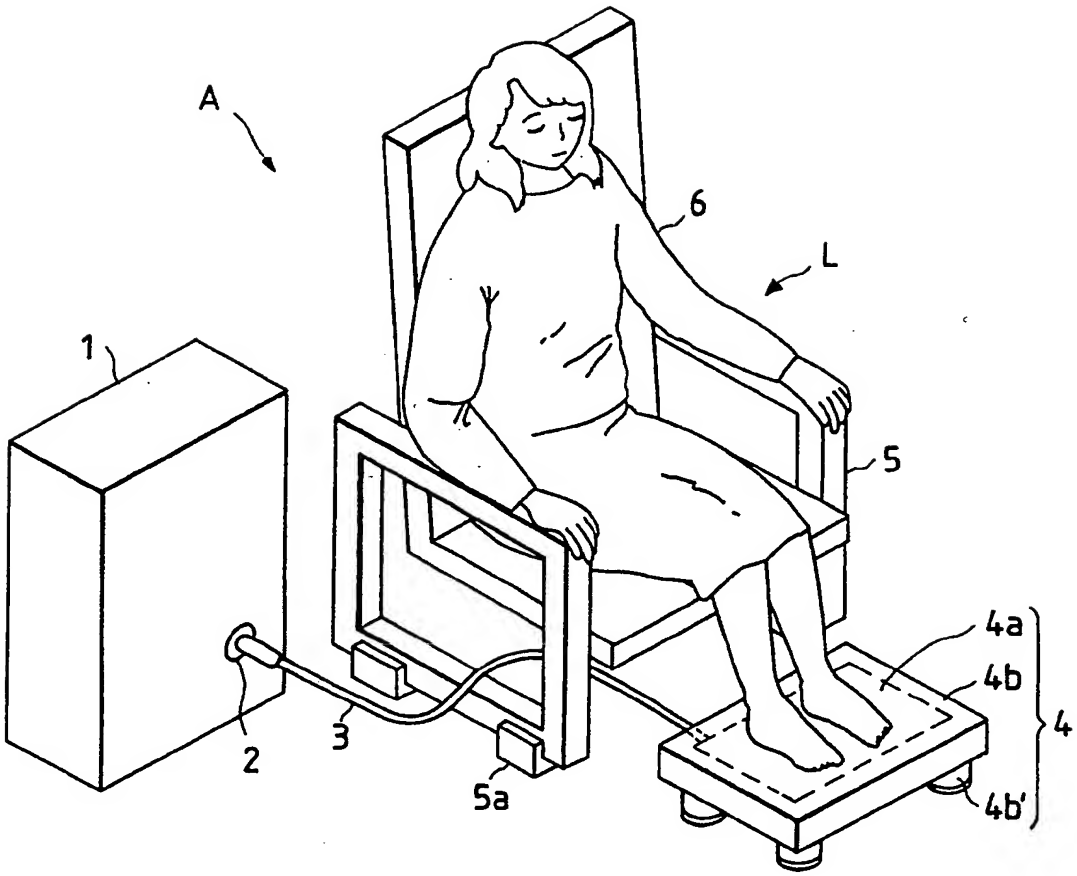


FIG. 2

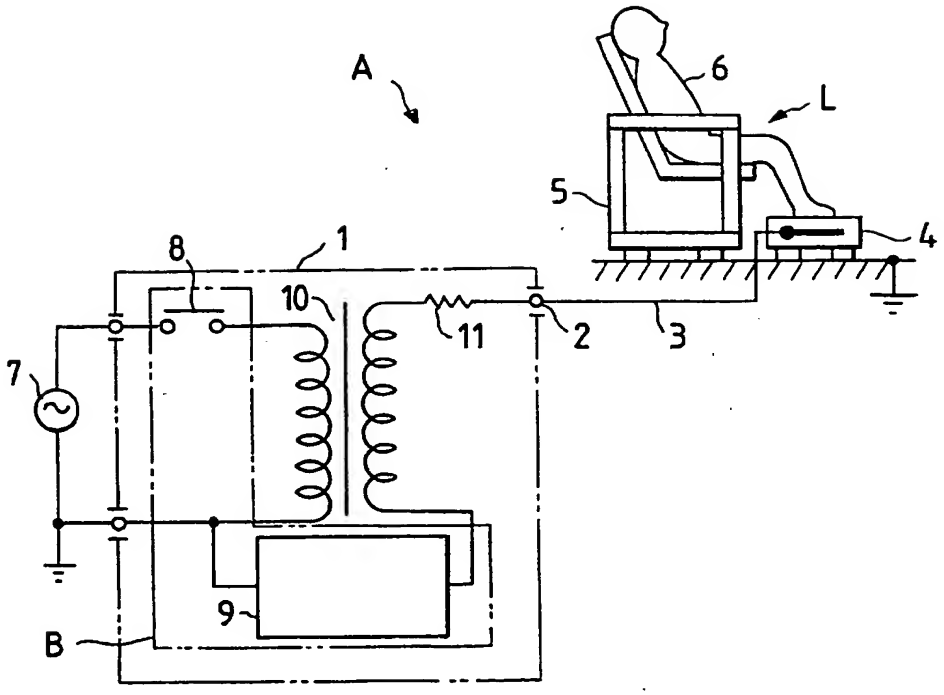


FIG. 3

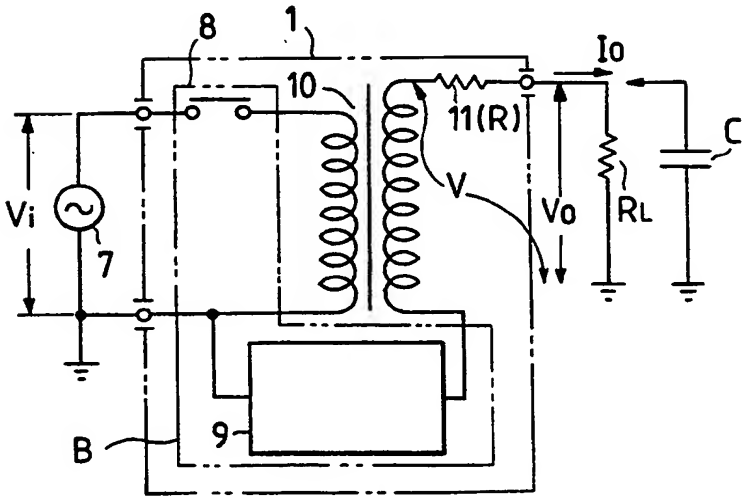


FIG. 4

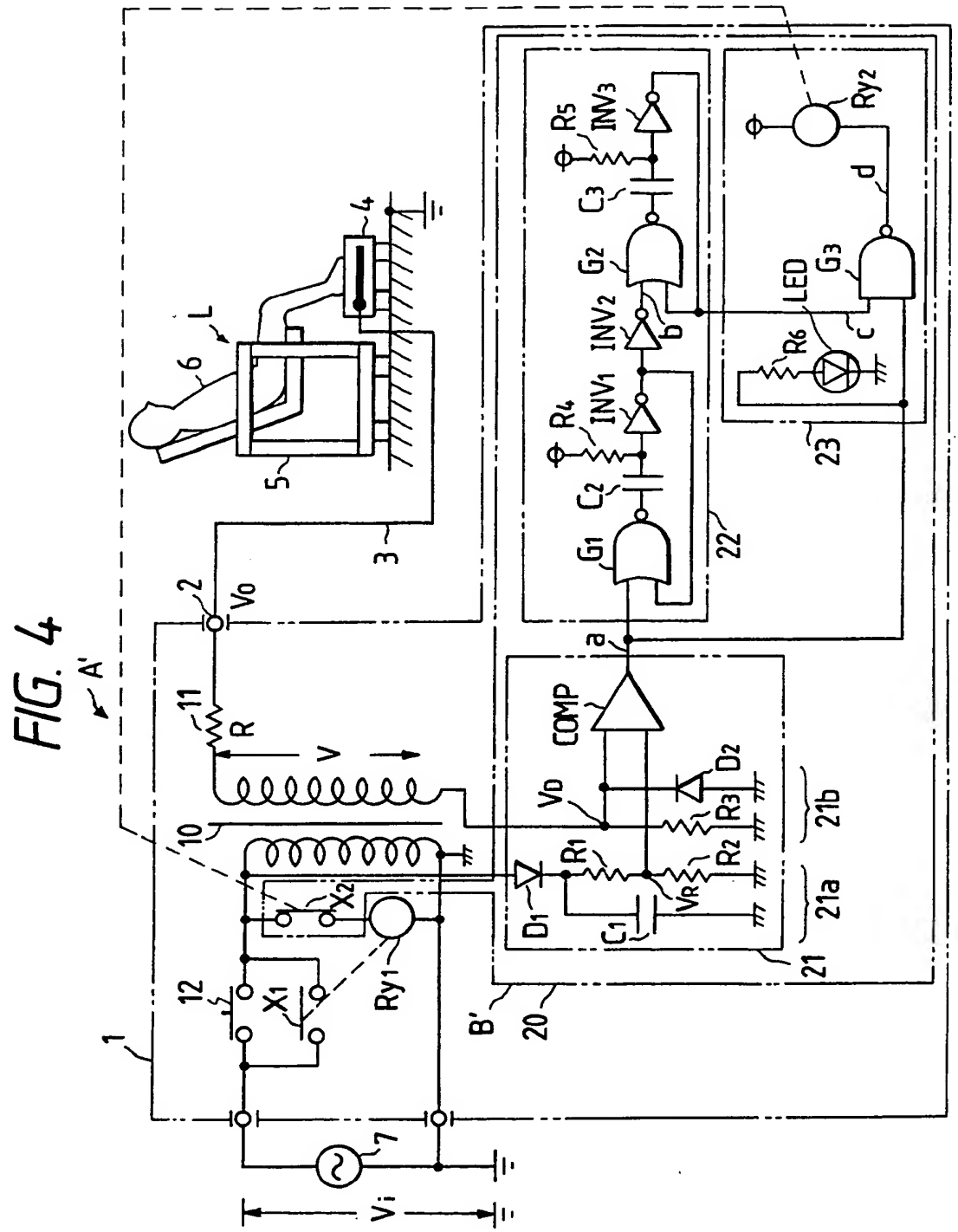


FIG. 5

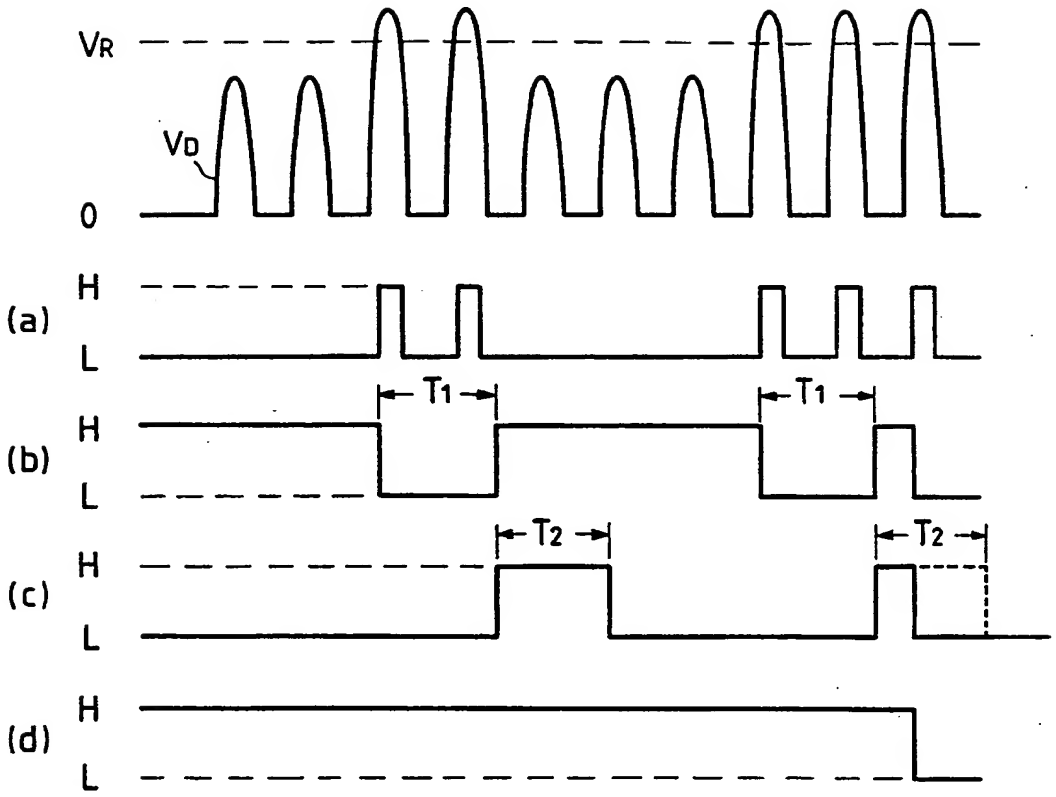
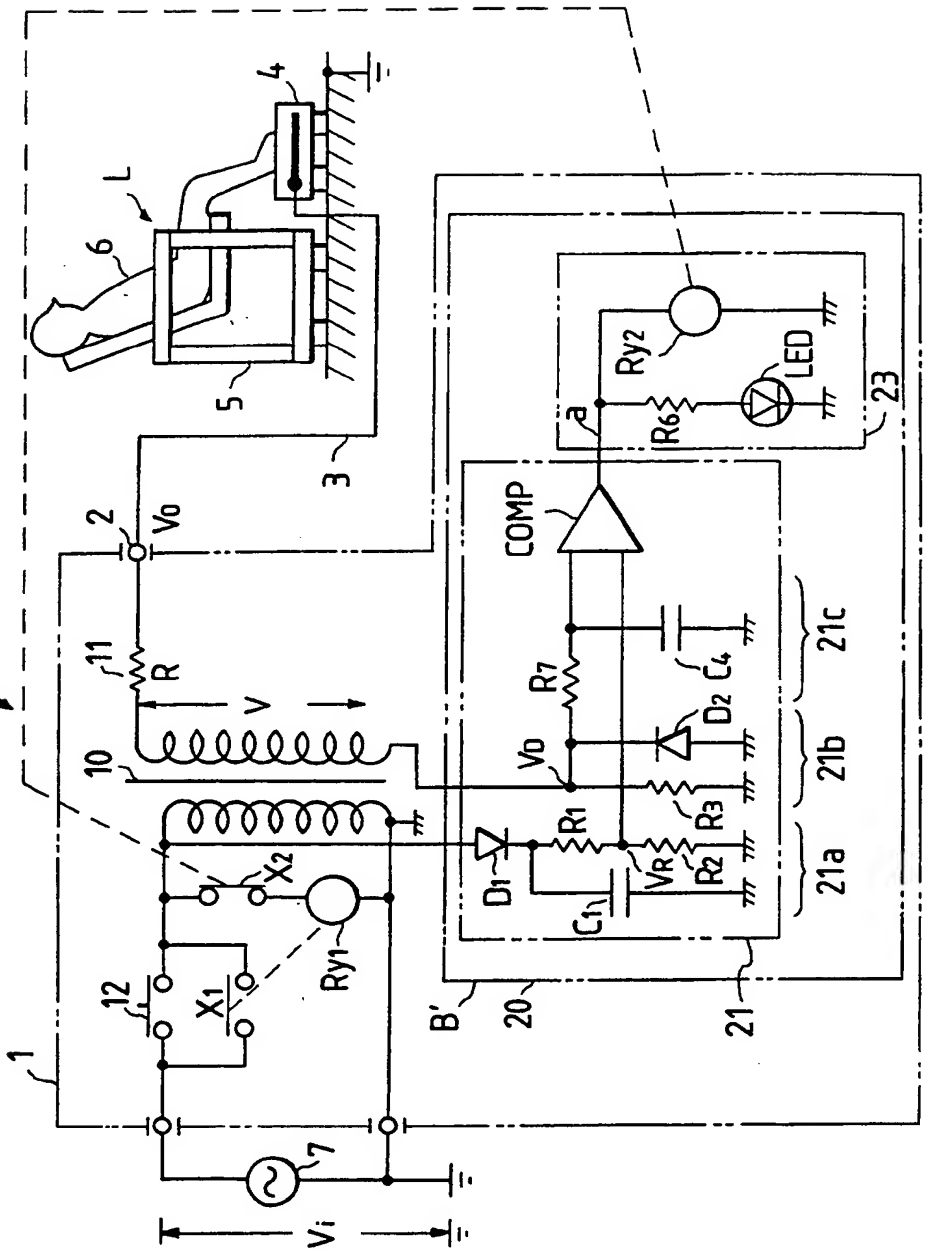


FIG. 6



ELECTRIC FIELD THERAPY APPARATUS

BACKGROUND OF THE INVENTION

[Field of the Invention]

This invention relates to an electric field therapy apparatus for performing a medical treatment utilizing a high voltage.

[Description of the Prior Art]

Fig. 1 is a perspective view of a conventional electric field therapy apparatus A in the state of normal use. The numeral 1 denotes a main body of the electric field therapy apparatus A, 2, a high voltage output terminal of the main body 1, 3, a high voltage-proof cord, and 4, an electric conductive element, respectively. The electric conductive element 4 comprises an electrode 4a to which a high voltage is applied from the main body 1, an insulating element 4b covering the marginal area of the surface of the electrode 4a, and insulating pieces 4b' for insulating the whole electric conductive element 4 from the floor. The numeral 5 denotes a chair, 5a, insulating devices for insulating the chair 5 from the floor, and 6, a human body subjected to medical treatment, respectively. In other words, the electric field therapy apparatus A comprises, in a rough classification, the main body 1 of the electric field therapy apparatus A and its

high voltage output terminal 2, and a load portion L (high voltage-proof cord 3, electric conductive element 4, chair 5, and human body 6).

For using this electric field therapy apparatus A, a part (for example, feet) of the human body 6 who sits on the chair 5 insulated from the floor (ground) by the insulating devices 5a is contacted onto the electric conductive element 4 which is covered with the insulating element 4b, and a high electric field is applied to the human body 6.

Fig. 2 shows a basic circuit of the electric field therapy apparatus A (including a safety device B) of Fig. 1, and identical reference numerals as those of Fig. 1 denote identical parts. The reference numeral 7 denotes a commercial power source, and 8, an output stopping relay contact, 9, an over current detection circuit for detecting an over current in order to immediately turn off the output stopping relay contact 8. This means that the output stopping relay contact 8 and the over current detection circuit 9 constitute the circuit of the safety device B in the electric field therapy apparatus A. The numeral 10 denotes a step-up transformer, and 11, a current limiting resistance.

In the safety device B of the above conventional electric field therapy apparatus A, when electric current more than a preset (to fix to a prescribed value) value flows to a secondary circuit of the step-up transformer 10, this over current

is detected by the over current detection circuit 9, and the output stopping relay contact 8 is turned off to stop the output. However, in the safety device B of such conventional electric field therapy apparatus A as mentioned, since the over current is detected comparing the preset current value with the secondary current of the step-up transformer 10, the preset current value is not changed even if voltage of the power source is fluctuated. Therefore, there is such a problem that for the sake of safety, the current value must be preset taking into consideration the expected fluctuation.

In an ideal safety device B, it is of course required not to supply a hazardous over current to the human body 6 in view of the medical treatment in which a high voltage is applied to the human body 6. Furthermore, it is required to provide a (safety) circuit which is actuated before the over current is actually occurred anticipating that a hazardous states will be created when the value of a load generating from the load portion L becomes more than a load (hereinafter referred to as the "preset load") supposed to be hazardous even if the current value is less than the preset value, in other words, a possibility that a hazardous current is applied to the human body 6. The actuating point must be determined only by the value of the preset load. At that time, any possible effect of the voltage fluctuation of the power source must be avoided as much as possible.

Fig. 3 is an equivalent circuit diagram showing the state of the load of Fig. 2. The reference character V_i denotes an input voltage of the commercial power source 7, V, a secondary voltage of the set-up transformer 10, V_o, an output voltage, I_o, an output current, R, a resistance value of the current limiting resistance 11, C, a load electrostatic capacity value when the load is entirely electrostatic capacity, and R_L, a load resistance value when the load is entirely resistance, respectively. Table 1 shows the results of calculation based on the equations (1) and (2) below. The results show how the resistance value for actuating the over current detection circuit 9 is changed when the input voltage V_i is varied by ± 10% under the conditions that the commercial power source 7 is: V_i=100V, 50Hz, no-load output voltage: V_o=10000V, current limiting resistance R is: a fixed value of 10MΩ , and preset value (actuating current) of the over current detection circuit 9: 500μ A.

In the case where the load is entirely resistance:

$$R_L = \frac{V}{I_o} - R \qquad \text{.....(1)}$$

In the case where the load is entirely electrostatic capacity:

$$C = \frac{1}{\omega \sqrt{\{(V/I_o)^2 - R^2\}}} \qquad \text{.....(2)}$$

wherein: $\omega = 2\pi f$

TABLE 1

Input voltage V_i (V)	Secondary voltage V (V)	Output current I_o (μA)	Actuating current preset value (μA)	Actuating load resistance value R_L' (MΩ) (C=0)	Actuating load electro-static capacity value C' (pF) ($R_L=\infty$)	
110	11000	500	500	12.0	162	◎
100	10000	500	500	10.0	184	◎
90	9000	500	500	8.0	213	◎

TABLE 2

Input voltage V_i (V)	Secondary voltage V (V)	Output current I_o (μA)	Actuating current value (μA)	Load resistance preset value R_L'' (MΩ) (C=0)	Load electro-static capacity preset value C'' (pF) ($R_L=\infty$)	
110	11000	550	500	10.0	184	◎
100	10000	500	500	10.0	184	◎
90	9000	450	500	10.0	184	x

TABLE 3

Input voltage V_i (V)	Secondary voltage V (V)	Output current I_o (μA)	Actuating current value (μA)	Load resistance preset value R_L'' (MΩ) (C=0)	Load electro-static capacity preset value C'' (pF) ($R_L=\infty$)	
110	11000	450	450	14.4	143	◎
100	10000	450	450	12.2	160	◎
90	9000	450	450	10.0	184	◎

In Tables 1, 2, 3 and Table 4 (as will be described),

the mark ◎ indicates that the safety device B and another safety device B' (as will be described) according to the present invention are actuated, while the mark x indicates that the device B is not actuated.

As apparent from the calculated values of Table 1, in the safety device B of the conventional electric field therapy apparatus A, the load values (values of the actuating load resistance value R_L' of Table 1) are varied in accordance with variation of the input voltage V_i, and even if the load resistance preset value R_L'', as apparent from Table 2, is set in such a manner as to be actuated at 10MΩ (I_o=500μA), the circuit of the safety device B is not actuated at 10MΩ of the load resistance value R_L when the voltage of the power source is lowered to 90V. In order to enable the circuit of the safety device B to be actuated at the preset value of 10MΩ of the load resistance value R_L even when the input voltage V_i is 90V, it was required that as shown in Table 3, the preset value of the load is set to be smaller than a desired value, i.e., the value of the load resistance preset value R_L'' is required to be set large (12.2MΩ of Table 3), and the actuating current value is required to be set small (450μA of Table 3). In this case, the circuit of the safety device ought to be actuated when the value of the actuating load resistance value R_L' becomes less than 10MΩ, but it is actuated at 12.2MΩ of Table 3. In the case

where the safety device B is set to be actuated at 100V of the input voltage V_1 and 10MΩ of the actuating load resistance value R_L' in Table 1, the safety device B is not actuated unless the actuating load resistance value R_L' is lowered to 8MΩ when the input voltage V_1 is lowered to 90V.

When the sensitivity of the circuit of the safety device B of the electric field therapy apparatus A is increased (the value of the load resistance preset value R_L'' is set to be large, that is, the actuating current is set to be small), there is a possibility that the output is stopped even at an temporary increase which is simply generated when the human body 6 is loaded onto and unloaded from the electric conductive element 4. When this happens, the user may mistake it for failure (of the apparatus). In order to avoid this unfavorable situation, the sensitivity of the circuit of this safety device B must be kept lowered to some extent.

SUMMARY OF THE INVENTION

This invention relates to an electric field therapy apparatus for performing a medical treatment utilizing a high voltage, in which an over load of its output circuit is detected and informed, an output is stopped, and means relating to safety is actuated.

An electric field therapy apparatus according to the present invention comprises an over load detecting circuit

including a detected value generating portion for setting a reference value in proportion to an input voltage inputted from a power source into a main body of the electric field therapy apparatus and generating a detected value in proportion to electric current of an output circuit of the main body, and a comparator for inputting the reference value and the detected value, the over load detecting circuit generating a control output from the comparator when the detected value inputted into the comparator becomes more than the reference value, safety means such as alarming means and output stopping means being actuated by this output signal, the safety means being actuated only when the detected value continuously exceeds the reference value for a predetermined time.

It is therefore an object of the present invention to provide an electric field therapy apparatus having a safety device which is normally actuated at a constant load value by varying a reference value in accordance with variation, if any, of voltage of a power source.

Another object of the present invention is to provide an electric field therapy apparatus having a safety circuit for generating a control output from a comparator when a detected value inputted into the comparator becomes more than a reference value.

A further object of the present invention is to provide

an electric field therapy apparatus having a safety circuit for generating a control output from a comparator so that a safety means such as alarming means and output stopping means are actuated in accordance with this output signal.

A still further object of the present invention is to provide an electric field therapy apparatus having a safety circuit for actuating a safety means only when a detected value continuously exceeds a reference value for a predetermined time.

These objects can be achieved by a constitution of an electric field therapy apparatus and its circuit constituting the present invention. Specific embodiments of the invention are exemplified in the accompanying drawings and the detailed description to follow. It is to be understood that minor rectifications and modifications of these embodiments are also included in the scope of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view schematically showing a conventional electric field therapy apparatus;

Fig. 2 is a schematic view showing a basic circuit of a safety device of the electric field therapy apparatus of Fig. 1;

Fig. 3 is an equivalent circuit diagram showing the state of load of Fig. 2;

Fig. 4 is a schematic view of an electric field therapy apparatus and its circuit diagram, according to one embodiment of the present invention;

Fig. 5 is a waveform diagram showing an activating state of the circuit of Fig. 4; and

Fig. 6 is schematic view of an electric field therapy apparatus and its circuit diagram, according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Fig. 4 shows an electric field therapy apparatus A' of the present invention and its circuit diagram. In Fig. 4, identical reference numerals as those of Fig. 1 denote identical parts. The reference character X_1 denotes a relay contact for holding a power source, X_2, a relay contact for stopping output, and Ry_1, a relay operating coil for holding a power source, respectively. The numeral 20 denotes a safety circuit constituting a safety device B'. The safety circuit 20 comprises an over load detecting circuit 21, a timer circuit 22, and an operating circuit 23.

The over load detecting circuit 21 comprises a reference value generating portion 21a including a diode D_1 for generating a reference value V_R in proportion to voltage of the power source, a smooth condenser C_1 and partial pressure resistors R_1 and R_2, and a detected value generating portion

21b including a converting resistor R_3 for converting an output current to a voltage, and a diode D_2 for converting a converted voltage to a half-wave detected value V_D, and a comparator COMP for comparing the detected value V_D with the reference value V_R and generating a positive voltage at the output side when the detected value V_D becomes more than the reference value V_R.

The timer circuit 22 comprises two monostable multivibrators including NOR gates G_1, G_2, inverters INV_1, INV_2, and INV_3, etc.

The operating circuit 23 comprises a NAND gate G_3, a light emitting diode LED, and an output stopping relay operating coil Ry_2 of an output stopping relay contact X_2. The numeral 12 denotes a power switch. The reference characters C_2 and C_3 denote condensers, and R_4, R_5 and R_6, resistors, respectively. A power circuit of the safety circuit 20 is not shown.

Fig. 5 is a main waveform diagram in the circuit diagram of Fig. 4. The reference characters V_R, V_D, and (a) through (d) correspond to voltages at positions indicated by V_R, V_D, and a through d of Fig. 4, respectively.

Operation of the embodiment of Fig. 4 will now be described with reference to Fig. 5. First, when the power switch 12 is pressed, electric current flows to the power source holding relay operating coil Ry_1 to close the power

source holding relay contact X_1. This closing state is maintained even if the power switch 12 is released. By this, a high voltage is generated to the output of the main body 1 of the electric field therapy apparatus to start the medical treatment with respect to the human body 6 placed on the electric conductive element 4.

At this time, when the state of the load portion L is changed by some reasons (change in temperature and moisture, accumulation of dust and the like, failure of the electric field therapy apparatus, insufficient insulation of the apparatus, etc.) and the value of the load becomes larger than the preset value (the detected value V_D of the comparator COMP becomes larger than the reference value V_R. Hereinafter, this state is referred to as the "abnormal state"), since the voltage at the point indicated by a on the output terminal side of the comparator COMP becomes a positive voltage as shown by a waveform (a), the light emitting diode LED of the operating circuit 23 is lighted up. Further, since the output of the COMP is inputted directly into the NOR gate G_1, a pulse having a width of a time constant T_1 determined by the resistor R_4 and the condenser C_2 appears on the output terminal side of the inverter $1NV_1$ in such a manner as to be in synchronism with a leading edge of the waveform (a). The waveform thus appeared is inverted to a waveform (b) by the inverter $1NV_2$. By inputting the

waveform (b) into the NOR gate G_2, a pulse having a width of a time constant T_2 determined by the resistor R_5 and the condenser C_3 appears on the output terminal side of the inverter INV_3, as shown by the waveform (c), in such a manner as to be in synchronism with a leading edge of the waveform (b), and it is then inputted into NAND gate G_3. When the aforementioned abnormal state occurs here during the time when the input terminal of the NAND gate G_3 is maintained to be a positive voltage by the pulse waveform (c), the output of the NAND gate G_3 becomes zero as shown by the waveform (d). Therefore, electric current is supplied to the output stopping relay operating coil Ry_2. As a result, the output stopping relay contact X_2 is opened, electric current to the power source holding relay operating coil Ry_1 is cut off, the power source holding relay contact X_1 is opened, and the output of the electric field therapy apparatus A is stopped.

At this time, as shown in Table 4, if the voltage of the power source is varied, the output current I_o is changed and at the same time, the reference value V_R is also changed to change (or correct) the actuating current value. Therefore, the device is actuated normally at a constant load value (preset load value). Accordingly, in the safety device B' of the electric field therapy apparatus A' of the present invention, the operating state is never changed, as in the safety device B of the conventional electric field therapy

apparatus A, when the voltage of the power source is changed even if the load remains constant.

TABLE 4

Input voltage V_1 (V)	Secondary voltage V (V)	Output current I_o (μ A)	Actuating current value (μ A)	Load resistance preset value R_L" (MΩ) (C=0)	Load electro-static capacity preset value C" (pF) ($R_L=\infty$)	
110	11000	550	550	10.0	184	◎
100	10000	500	500	10.0	184	◎
90	9000	450	450	10.0	184	◎

In the above embodiment, the voltage value is used for the reference value V_R and the detected value V_D. However, it may be other physical value such as, for example, electric current value, temperature value, light quantity value and the like.

Fig. 6 shows one embodiment in which a timer function with an integrating circuit 21c is used at the input step of the comparator COMP. R_7 denotes an integrating resistor, and C_4 denotes an integrating condenser. Identical reference numerals as those of Fig. 4 denote identical parts.

In this embodiment, even if the current flowing to the output circuit is increased by some reasons as mentioned above and the detected value V_D exceeds the reference value V_R, the output side of the integrating circuit 21c does not become that voltage soon. Instead, it becomes for the first

time the same voltage as the detected value V_D only after the passage of the time constant which is determined by the integrating resistor R_7 and the integrating condenser C_4. An output is outputted from the comparator COMP to light up the light emitting diode LED of the operating circuit 23. At the same time, electric current is supplied to the output stopping relay operating coil Ry_2 to open the output stopping relay contact X_2. As a result, the electric current to the power source holding relay operating coil Ry_1 is cut off to open the power source holding relay contact X_1. As a consequence, the output of the electric field therapy apparatus A' is stopped. At this time, if the detected value V_D is lowered less than the reference value V_R before the output is outputted from the comparator COMP, the output is not outputted. Accordingly, the operating circuit 23 is not actuated, and the light emitting diode LED is not lighted up, and the output is not stopped.

In the embodiment of Fig. 4, although the operating circuit 23 is actuated through the timer circuit 22, the operating circuit 23 may be actuated directly by the output of the over load detecting circuit 21 and not by way of the timer circuit 22.

In the electric field therapy apparatus of the present invention, when the detected value is varied in accordance with variation of the voltage of the power source, the

reference value of the comparator is also varied in proportion to the voltage of the power source. Accordingly, the safety device is not actuated even if the voltage of the power source is varied, as long as the load is present within a normal range. In other words, it is not affected by variation of the voltage of the power source and always actuated by a preset load. If it is set to be actuated only when the abnormal state is maintained more than a predetermined time, it is not actuated by a temporary increase of load which is simply generated when the patient is loaded on and unloaded from the electric conductive element. Therefore, the patient will never mistake it for a failure of the apparatus.

WHAT IS CLAIMED IS:

1. An electric field therapy apparatus comprising an over load detecting circuit including a reference value generating portion for generating a reference value in proportion to an electrical signal input from a power source into a main body of the electric field therapy apparatus, a detected value generating portion for generating a detected value in proportion to electric signal from an output circuit of said main body, and a comparator for receiving the reference value and the detected value, said over load detecting circuit generating a control output from said comparator when the detected value inputted into said comparator becomes more than said reference value.

2. An electric field therapy apparatus as claimed in claim 1, further comprising safety means, such as alarming means and output stopping means, which is actuated by the control output generated from said comparator.

3. An electric field therapy apparatus as claimed in claim 1, further comprising a timer circuit for outputting a

control output only when the detected value continuously exceeds the reference value for a predetermined time or more.

4. An electric field therapy apparatus substantially as hereinbefore described with reference to and as shown in Figures 4 and 5, or Figure 6 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9222122.5

Relevant Technical fields

(i) UK Cl (Edition L) A5R (RHFE) H2K (KHB, KSX)

(ii) Int Cl (Edition 5) A61N (1/08, 1/40)
H02H (1/04, 3/08, 3/093, 3/40, 7/00)

Search Examiner
PAUL NICHOLLS

Databases (see over)
(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search
18 JANUARY 1993

Documents considered relevant following a search in respect of claims 1-4

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1594021 A (WESTINGHOUSE) whole document	1,2
X	GB 693838 A (BRILL AND SCHNELL) whole document	1,2
X	EP 0269846 A1 (SIEMENS) whole document	1.2

Category	Identity of document and relevant passages	Relevant to claim(s.

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Published 1993 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.